STATUS OF MINERAL RESOURCE INFORMATION FOR THE NAMBE, POJOAQUE, SAN ILDEFONSO, SAN JUAN, SANTA CLARA, AND TESUQUE INDIAN RESERVATIONS, NEW MEXICO

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SUMMARY AND CONCLUSIONS

Commercial mineral production on the six reservations has been limited to common clay, sand, gravel and pumice. Presently, three commercial sand and gravel operations are active; two on the San Ildefonso Reservation and one on the Tesuque Reservation.

Limited uranium resources may be present on the reservations. At this time, the probability of discovering ore bodies is not good, as indicated by extensive prospecting.

The area has been explored for oil, gas and geothermal energy. Prospects for discovery of commercial quantities of these commodities probably will continue to stimulate and encourage private exploration efforts.

Common clay is made into pottery products that are not only used by the resident population but are also sold to tourists. Adobe is abundant in the sedimentary deposits underlying most of the reservations. Adobe is used on the San Juan Reservation in a federally funded operation that manufactures adobe brick for sale to local builders. A commercial adobe brick manufacturing operation might also be developed on the Tesuque Reservation if a large enough market for the product exists in Santa Fe.

Three commercial sand and gravel operations are active on two of the reservations. The quantity and quality of sand and gravel deposits on the reservations is not known precisely. Sand and gravel is produced from two areas on the San Ildefonso Reservation. The combined total production from these two operations is less than 100,000 cubic yards per year. Numerous inactive or intermittently used gravel pits are present on the Rio Grande flood plain on the San Ildefonso Reservation. Sand and gravel is being produced also from a relatively new pit on the Tesuque Reservation. At the present rate of production from this pit, about 20,000 cubic yards per year of material should be produced. Sand and gravel produced in this area is primarily used in concrete for building purposes and in highway construction. The potential for developing more or larger sand and gravel operations depends heavily upon increasing the local demand. Sand and gravel is not a scarce commodity in this area; but the competition for the local market from other sources is stiff. A detailed study of the sand and gravel deposits that occur on the reservations might be considered by the tribes.

Areas of anomalous radioactivity are present on the Nambe, the Pojoaque, and the Tesuque Reservations. Although uranium minerals were discovered on public land southeast of Espanola in 1954, extensive prospecting by individuals, private companies, and the U.S. Atomic Energy Commission has failed to produce any ore bodies in the area. Further field study on the Pojoaque and Nambe Reservations might reveal uranium ore, but the probability of discovering ore bodies is not good.

The Rio Grande rift is an area of high subsurface heat flow, and the Valles Caldera in the Jemez Mountains just west of the reservations is a Known Geothermal Resource Area (KGRA). Both the Santa Clara and the San Ildefonso Reservations contain land classified as valuable for geothermal energy by the USGS, but that on the San Ildefonso Reservation amounts to only a few hundred acres at the western end of the Sacred Area. Most private companies attempting to develop geothermal energy in this region seem to be interested in land several miles west of the Sacred Area. The Santa Clara Reservation contains about 20,000 acres of geothermal land and Amax Exploration, Inc., is working on geothermal leases adjacent to the western end of the reservation.

INTRODUCTION

This report was prepared for the Bureau of Indian Affairs (BIA) by the U.S. Geological Survey (USGS) and the Bureau of Mines (USBM) under an agreement to compile and summarize available information on the geology, mineral resources, and potential for economic development of certain Indian lands. Source material included published and unpublished reports, and personal communication. No field work was done.

Location and Access

The Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Indian Reservations are in north-central New Mexico (Figure 1). The six reservations are clustered in northern Santa Fe County, southeastern Rio Arriba County, and northeastern Sandoval County. The Indian population on the reservations consists primarily of distinct groupings of Tewa Indians, and all but the Pojoaque people have recognizable pueblos on the reservations. Most of the Indians live in or near these pueblos. Population and acreage figures for each reservation are shown in Table 1.

TABLE 1
Population and acreage statistics of Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Pueblos, New Mexico*

Reservation	Total resident Indian population	Potential labor force	Tribally owned (acres)	Government owned (acres)
Nambe	353	163	19,073	2
Pojoaque	76	38	11,601	0
San Ildefonso	397	168	26,191	1
San Juan	1783	1051	12,236	2
Santa Clara	1820	1023	45,744	4
Tesuque	290	168	16,810	3
TOTAL	4719	2611	131,655	12

*From data compiled in April 1979 by the Bureau of Indian Affairs office in Santa Fe, New Mexico.

Access to the reservations is provided by U.S. Highways 84 and 285, and by New Mexico-State Highways 4, 5, 30, 68, and 76. Several other state highways and numerous improved and unimproved BIA roads crisscross the reservations. The Atchison, Topeka, and Santa Fe Railway serves the region, but the nearest station is at Santa Fe, south of the reservations.

Albuquerque (population 243,751), the only large metropolitan area in New Mexico, is 70 to 85 miles southwest of the reservations. Santa Fe (population 41,167) is 10 to 25 miles south of the various reservations. Los Alamos (population 15,198) is 5 miles west of the San Ildefonso Reservation boundary, and Espanola (population 4,136) is within the Santa Clara Reservation. Population figures cited are from the 1970 census by the U.S. Department of Commerce.

Mineral Rights

With one exception, the Indians apparently hold all mineral rights on the tribally owned lands within the reservations. On the Santa Clara Reservation, the Federal Government holds the rights to gold, silver, and mercury in a 490-acre strip of land along Santa Clara Creek. According to the Code of Federal Regulations Title 43, subpart 3561, the tribe, as the owner of the surface lands, has the right to lease land within the strip from the government for gold, silver, and mercury production, subject to a payment of royalty of 5 to 12.5 percent on any such production.

Master title plats of the Bureau of Land Management (BLM) show many private land claims and small holding claims within the reservation boundaries (Figure 2). According to Bureau of Indian Affairs (BIA) officials in the Santa Fe Office (personal communication, November 6, 1979), land ownership is very complex in certain areas on the reservations. They believe generally that land in towns and along river bottoms on the reservations is privately owned and that land on the higher ground is tribally owned. According to BLM personnel in Santa Fe (personal communication, November 7, 1979), mineral rights and surface ownership for the claims probably were transferred to the original claimants. Much uncertainty seems to exist in both agencies about the ownership of mineral rights on these privately held lands.

Previous Work

Sedimentary rocks in the Espanola basin have been studied for more than a hundred years (Hayden, 1869; Cope, 1874 and 1875). In the first half of this century, people such as Bryan (1938) and Frick (1926) carried on further investigations of the Santa Fe Formation or Group and the fossils in these rocks. Recently, numerous geologists and geophysicists have investigated all aspects of the Rio Grande rift.

Manley (1979a and 1979b), Galusha and Blick (1971), Baldwin (1956), and Kelley (1978 and 1979) examined the geology and geomorphology of the Espanola basin. Kelley (1952) and Woodward and others (1978) discussed the tectonics of the Rio Grande rift. Abrahams and others (1961), Griggs (1964), Spiegel and Baldwin (1963), and Borton (1979) studied groundwater in the area.

Some of those who investigated mineral resources in the area are Arnold and others (1977), Black (1979), Bush (1973), Clippinger (1946), Clippinger and Gay (1947), Elston (1961 and 1967), File (1965), File and Northrop (1966), Hawks (1970), Kelley (1948), Redmon (1961), Siemers and Austin (1979b), and Bingler (1968). Collins and Freeland (1956), Hilpert (1969), and Chenoweth (1979) covered uranium occurrences in the area.

PHYSIOGRAPHY

The reservations are located in the Espanola basin, the northernmost of several structural basins that make up the Rio Grande depression in New Mexico (Manley, 1979b). Within the structural basin is a topographic basin or valley (Figure 3), the boundary of which is outlined by the eastern edge of the Pajarito plateau, the mesas southeast of the Brazos and Tusas ranges, Black Mesa, the edge of the Sangre de Cristo uplift, the northern edge of the Santa Fe plateau and the Cerros de Rio. Both the basin and the Espanola valley are centered about the confluence of the Rio Grande and the Rio Chama (Kelley, 1979). The Rio Grande flows into the northeastern part of the valley from a deep narrow gorge in the Taos Plateau and leaves the southwestern part through a deep gorge (White Rock Canyon)eroded into the Cerros del Rio and Pajarito plateaus. The Rio Chama flows into the northwestern part of the valley and joins the Rio Grande on the San Juan Reservation.

The Espanola valley has been eroded into a broad open upland; the arid climate and weakness of the Santa Fe beds have resulted in great arrays of badlands and numerous sand and gravel filled arroyos. The Rio Grande and Rio Chama, and several of the major tributaries, including the Santa Cruz, Pojoaque and Tesuque, locally have wide flood plains. Sparsely vegetated badlands occupy the western part of the Nambe and San Juan Reservations, most of the Pojoaque, and the eastern parts of the San Ildefonso and Santa Clara Reservations. The Tesuque Reservation is mostly narrow gullies and sharp ridges with sparse grass and juniper trees. The eastern end of the Nambe Reservation is in the pine-forested foothills of the Sangre de Cristo Mountains, and the western parts of San Ildefonso and Santa Clara Reservations are on the Pajarito Plateau and on the flanks of the Jemez Mountains. Altitudes vary from about 8,500 feet on the eastern part of the Nambe and 10,760 feet on the western part of the Santa Clara to 5,450 to 5,600 feet on the flood plain of the Rio Grande. Remnants of terraces and terrace gravels are common along the major rivers and landslides are prevalent along all of the lava-capped mesas, notably along White Rock gorge on the San Ildefonso Reservation.

GEOLOGY

General

In the area encompassed by the reservations, erosion has exposed a thick sequence of Miocene to Pleistocene sedimentary rocks and Pliocene to Pleistocene volcanic rocks. Quaternary terrace gravels, landslides, and alluvial deposits occur along the Rio Grande and its tributaries. Precambrian granite and metamorphic rocks with Mississippian and Pennsylvanian sedimentary rocks crop out along the Sangre de Cristo uplift in the Nambe Reservation.

The distribution of rock units and major faults on the reservations and surrounding areas are shown on the generalized geologic map (Figure 4 and Figure 5). The geologic map was adapted from Smith and others, 1970; Baltz, 1978, p. 217; Galusha and Blick, 1971; Manley and others, 1978; and Wyant and Olson, unpublished manuscript map.

Stratigraphy

Precambrian rocks

The only Precambrian rocks on the reservations are exposed in the eastern part of the Nambe Reservation, where they are composed mostly of metamorphic rocks intruded by granitic plutons; pink granite, granodiorite, gneiss, quartzite, and amphibolite schist have been identified (Baltz, 1978, p. 215). The composite thickness of the exposed metamorphic rocks in the Sangre de Cristo uplift is about 20,800 feet according to Montgomery (1963, p. 9). Rubidium-strontium dates of quartz monzonite plutons range from 1,673+ 41 m.y. to about 1,400 m.y. (Long, 1974), with ages of pegmatites as young as about 1,300 m.y.

Sedimentary Rock Units

Mississippian and Pennsylvanian Rocks

The Espiritu Santo, Tererro, Sandia, and Madera Formations are exposed in faulted blocks on the Nambe Reservation, and have been penetrated in wells near some of the other reservations.

<u>Espiritu Santo Formation</u>

The Espiritu Santo Formation, only the uppermost 30 feet of which have been measured, is a marine limestone and sandstone of lower Mississippian age.

<u>Tererro Formation</u>

The Tererro Formation is a marine limestone and limestone breccia of upper Mississippian age, about 30 feet thick.

<u>Sandia Formation</u>

The Sandia Formation (Pennsylvanian) is composed of marine and nonmarine shale, sandstone, conglomerate, and thin limestone beds. The lower member of the Madera Formation combined with the Sandia Formation is equivalent to the La Pasada Formation of Miller and others, 1963. The Sandia Formation is about 200 feet thick.

<u>Madera Formation</u>

The Madera Formation (Pennsylvanian) is divided into upper and lower members. The upper member is marine and nonmarine shale, arkosic sandstone, and limestone about 750 feet thick. The upper member is equivalent to the Alamitos Formation of Miller and others, 1963. The lower member of the Madera Formation is marine shale, limestone, and sandstone, about 135 feet thick.

Tertiary Rocks

Tertiary rocks, composed predominantly of the Tesuque and Ancha Formations of the Santa Fe Group along with Pliocene volcanic rocks, are exposed on the reservations. The Santa Fe Group crops out on all the reservations. The volcanic rocks are exposed only on the Santa Clara and San Ildefonso reservations.

The Espanola basin is the type area for the Santa Fe Group and has been described in detail by Galusha and Blick (1971), Spiegel and Baldwin (1963), Manley (1979), and many others. Vertebrate fossils have been extensively studied and used in correlation (Kues and Lucas 1979). Santa Fe deposition occurred during the Miocene and Pliocene periods over a time span of about 12 million years. The sediments were derived from source areas, such as the Sangre de Cristo Mountains, that were marginal to the Rio Grande trough, and from active local volcanism. Most of the sediments were laid down by coalescing alluvial fans and piedmonts under a wide range of fluvial conditions.

The volcanic rocks of the Jemez Mountains and the basalts, lavas, and tuffs of the Cerros del Rio, were deposited during Pliocene time. The volcanic rocks intertongued with Santa Fe sediments in some areas and covered them in others.

<u>Santa Fe Group-Tesuque Formation</u>

The Tesuque Formation of the Santa Fe Group (Miocene) is exposed on all of the reservations. It is a basin-filling unit of poorly sorted, partly consolidated arkosic sand, silt, clay, and gravel, pink to light reddish brown and tan. It contains copious amounts of pebble- to cobblesized gravel derived from Precambrian metamorphic and igneous rocks and Paleozoic sedimentary rocks. Locally abundant layers of white or green volcanic ash and some conglomerate with latite and andesite clasts are present. Local flows of olivine basalt are interbedded with the sediments. The lithology of the Tesuque Formation varies considerably. Reflective of the source areas, the Tesuque Formation is more arkosic toward the Sangre de Cristo Mountains and contains more volcanic debris toward the Jemez Mountains. Its thickness is also variable, ranging from 0 to 5,000 feet within the Espanola Basin. Uranium minerals (carnotite, schroekingerite, and meta-autunite) have been identified within the Tesuque Formation, coating fractures and bedding surfaces in sandstone, siltstone, and claystone (Chenoweth, 1979).

<u>Santa Fe Group-Ancha Formation</u>

The Ancha Formation of the Santa Fe Group (Pliocene) is piedmont slope gravel and local fan breccias derived mainly from Precambrian rocks. It ranges in thickness from 0 to 300 feet.

Lobato Basalt

The Lobato Basalt, of Miocene age, is composed of olivine-augite and titaniferous augite basalts commonly containing xenocrystic quartz. It is predominantly in flows of 0 to 600 feet in thickness, but also occurs in dikes and sills intruded into rocks of the Santa Fe Group. The only exposures of the Lobato Basalt on the reservations are in the west-central part of the Santa Clara Reservation along its northern and southern boundaries. It crops out much more abundantly north of the reservation where it has been dated at 9.6 + 0.3 million years (Luedke and Smith, 1978).

Tschicoma Formation

The Tschicoma Formation of Miocene age is composed predominantly of coarsely porphyritic dacite, rhyodacite, and quartz latite containing pyroxene, hornblende, biotite, plagioclase, and rare quartz phenocrysts. It occurs in thick massive flows and domes (0-3,000 feet thick) which are exposed in an area covering most of the western third of the Santa Clara Reservation. Age dates for the Tschicoma Formation within the reservation are 6.69 + 0.33 and 5.50 + 0.82 million years (Luedke and Smith). The Pajarito fault zone is the eastern boundary of exposures of the Tschicoma Formation. Associated pyroclastic material is found in the Puye Formation further east.

Puye Conglomerate

The Puye Conglomerate (Pliocene) is composed of 50 to 700 feet of cobbles and boulders of andesitic, latitic, basaltic and rhyolitic rocks in a tuffaceous sand and pebble matrix. Minor amounts of quartzite and granitic rocks are also present. It is interbedded with the Tschicoma Formation and with the basaltic rocks of the Cerros del Rio. The Puye Conglomerate is exposed in the central third of the Santa Clara Reservation. The western boundary of the Puye is the Pajarito fault zone and the eastern boundary is the present Rio Grande river valley. Outcrops of the Puye extend southward through west-central San Ildefonso Reservation to contacts with the Bandelier tuff and the Cerros del Rio rocks, which overlie the Puye.

Servilleta Formation

The Servilleta Formation of Pliocene age is a dark-gray microvesicular olivine tholeiite basalt flow. It rests disconformably on the rocks of the Santa Fe Group and caps the Black Mesa north of the San Juan Reservation. The maximum thickness is about 60 feet. It has been dated at 2.78 + .44 million years (Manley, 1976b). There are no outcrops of the Servilleta Formation within the boundaries of the reservations but a landslide deposit in the northwest corner of the San Juan Reservation does include some blocks of Servilleta.

Basaltic Lavas and Tuffs of Cerros del Rio

The rocks of the Cerros del Rio (Pliocene-Pleistocene) are mainly basaltic andesite flows and tuffs 0 to 1,500 feet thick, commonly containing quartz xenocrysts. The outcrop of these rocks within the reservations is restricted to an area in south-central San Ildefonso Reservation. The Cerros del Rio is directly south of these outcrops. An average age for the Cerros del Rio rocks is 2.6 + 0.4 million years (Bachman and Mehnert, 1978). Manley (1976b) reports 1.96 + .06 million years.

Quaternary Rocks

The Bandelier Tuff

The Bandelier Tuff, 30 to more than 900 feet thick, is a gray to buff nonwelded to densely welded ash-flow deposit consisting of rhyolite ash and pumice, typically containing bipyramidal quartz and moonstone phenocrysts. The Bandelier Tuff is exposed in cliff-forming outcrops in south central and western Santa Clara Reservation. The age of the Bandelier Tuff has been measured (from potassium-argon) as 1.02 + .04 million years (Doell and others, 1968, p. 211-248).

Terrace Gravels

Terrace gravels of the Chama River and Rio Grande and their tributaries are composed of well-rounded pebbles, cobbles, and boulders of Precambrian quartzite, crystalline rocks, and subordinate volcanic rocks in a sand and silt matrix. Exposures of the terrace gravels occur along the Rio Grande in the San Juan, Santa Clara, and San Ildefonso Reservations.

Landslide Deposits

Landslide deposits are found in southern San Ildefonso Reservation and northwestern San Juan Reservation. Both of these slide areas occurred when basaltic rocks slid down steep slopes over the underlying partly consolidated and eroded conglomerate and sandstone.

Alluvial Deposits

Alluvial deposits are present on all the reservations. These consist of silt, sand, and gravel in recent stream valleys, along with minor amounts of slope wash and fan deposits from transient streams with steep gradients.

Structure

The Espanola Basin is the dominant structural unit within the area of the Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Reservations (Figure 3). It is somewhat asymmetric, with the structurally deepest part west of the Rio Grande, trending southwest from Espanola to Los Alamos under the Pliocene-Pleistocene Jemez volcanic pile. The volcanic rocks cover a thick sequence of Miocene Santa Fe sediments which fill the basin. The Pajarito fault zone is the western boundary of the basin; the main displacement is down to the east along the zone, although some faults are downthrown to the west. The faults have had recurrent movement and show displacements from 300 to 400 feet, diminishing northward. A complex zone of small north-south trending faults occurs in the deepest part of the basin, west of the Rio Grande. A gently westward-tilted and warped structural slope is east of the Rio Grande. This structural slope is surfaced by Miocene sedimentary rocks of the Santa Fe Group. The dips on the surface are generally 2° to 10° west with locally varying 25° to 30° dips near the margin of the Sangre de Cristo uplift. Several zones of north trending normal faults in the eastern basin area were mapped by Galusha and Blick (1971). Most of the faults are downthrown to the east with dip slips of only a few feet. The eastern border of the Espanola basin is the Sangre de Cristo uplift. The boundary is defined by a north trending zone of tilted and faulted blocks downthrown to the west composed of Santa Fe Group, Mississippian and Pennsylvanian rocks, and Precambrian crystalline rocks.

MINERAL RESOURCES

General

The only mineral resources known to have been produced commercially on the six reservations are clays, pumice, and sand and gravel. Clays are present on all six reservations. The clays are used in manufacturing adobe bricks and in producing pottery. Pumice is mined from the middle Pleistocene Bandelier Rhyolite Tuff in the Jemez Mountains and is used locally as a lightweight aggregate in manufacturing building blocks (Elston, 1967). Apparently, pumice was mined many years ago on the Santa Clara Reservation (Sheffer, 1962). Sand and gravel deposits are present on all six reservations. Sand and gravel is produced commercially at two sites on the San Ildefonso Reservation and at one site on the Tesuque Reservation.

Oil and gas have not been reported on any of the reservations, but the USGS has classified most of the land as valuable for oil and gas because it is underlain by a minimum of 1,000 feet of sedimentary rocks (USGS Area Geologist, personal communication, November 5, 1979). An exact description of this land is given in Table 2. Only two exploratory wells have been drilled near the reservations. According to USGS records, the E. M. Elliott No. 1 well, in the NW ¼ NE ¼ sec. 26, T. 21 N., R. 9 E., was drilled to a depth of 1,685 feet during the years 1928 to 1931. The USGS records state that no oil or gas shows were found and that the well was plugged and abandoned in 1937. Black (1979, p. 276) shows different information for this same well. According to Black (1979), the well was drilled to a depth of 1,760 feet, oil shows occurred at 775 feet and at 1,100-1,125 feet, and a gas show occurred at 1,175-1,200 feet. According to USGS records, the Castle and Wigzell Kelly Federal No. 1 well, in the SW ¼ SW ¼ sec. 11, T. 20 N., R. 9 E., was drilled to a depth of 2,703 feet during 1961. The USGS records do not mention any oil or gas shows, and they state that the well was plugged and abandoned in 1963. According to Black (1979), minor oil shows were reported in this well. The U. S. Geological Survey has classified the land in this area as without value for other leasable minerals.

TABLE 2

Land Classified as Valuable for Oil and Gas by the U.s. Geological Survey in the Vicinity of Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Indian Reservations, New Mexico

T. 18 N., R. 9 E., N.M.P.M., New Mexico
secs. 2 to 11, inclusive;
secs. 14 to 23, inclusive;
secs. 26 to 35, inclusive.

T. 1 N., R. 7 E.,
secs. 1 to 6, inclusive;
sec. 7, N ½;
secs. 8 to 17, inclusive;
secs. 20 to 29, inclusive;
secs. 32 to 36, inclusive.

T. 19 N., R. 8 E.

T. 19 N., R. 9 E.,
sec. 1, N ½;
secs. 2 to 11, inclusive;
secs. 14 to 23, inclusive;
secs. 26 to 35, inclusive.

T. 19 N., R. 10 E.,
sec. 6, N ½.

T. 20 N., R. 6 E.,
secs. 1, 2, 11 to 14, inclusive;
secs. 24 and 25.

T. 20 N., Rs. 7, 8, and 9 E.

T. 21 N., R. 6 E.,
secs. 1 to 4, inclusive;
secs. 9 to 16, inclusive;
secs. 21 to 27, inclusive;
secs. 34 to 36, inclusive.

T. 21 N., Rs. 7, 8, and 9 E.

T. 22 N., Rs. 8 and 9 E.

Chenoweth (1979) gives a good synopsis of uranium activities in the Santa Fe area. After the discovery of uranium minerals southeast of Espanola in July 1954 by L. E. Rogers, Q. B. Rogers, and H. R. Rogers, the entire area was prospected, and hundreds of claims were staked east of the Santa Clara Reservation and north of the Nambe and Pojoaque reservations in T. 20 N., R. 9 E. According to Chenoweth, most of the uranium found in the area occurs in about a 100-meter-thick interval in the Tesuque Formation of the Santa Fe Group. Carnotite, schroekingerite, and meta-autunite coat fractures and bedding surfaces, and concentrate near clay gall zones and pockets of carbonaceous plant material that occur in the poorly consolidated sandstone, siltstone, claystone, and tuffaceous units of the Tesuque Formation. Chenoweth states that 11.8 metric tons or rock averaging 0.05 percent U_3O_8 was shipped from the San Jose No. 13 claim in the SE ¼ NW ¼ sec. 29, T. 20 N., R. 9 E. The shipment was experimental and apparently no more were made. Chenoweth concludes that, although the Santa Fe Group underlies most of the valley, the most favorable area for uranium accumulation seems to be near Pojoaque, but he also states that no ore bodies have been developed even though the region has been prospected heavily for more than 20 years.

The Rio Grande rift is an area of high heat flow (Reiter and others, 1975) and a potentially favorable area for the production of geothermal energy. Reiter and others (1976) studied heat flow data from the vicinity of Valles Caldera in the Jemez Mountains and discovered that higher heat flows occur in the western part of the caldera. Reiter concluded that a heat source was present at relatively shallow depths on the western side of the Valles Caldera in the vicinity of Redondo Peak.

Los Alamos Scientific Laboratory (LASL) has done extensive field and laboratory work on geothermal energy in this area. The geothermal energy project being conducted by LASL at the Fenton Hill site west of the Valles Caldera is an attempt to prove that heat energy can be extracted from the hot, dry rock at depth in this area and used to generate electricity. Hatton (Arnold and others, 1977) describes the project as consisting originally of two drill holes about 10,000 feet deep connected by a fracture system that was created hydraulically in the rock. Cold water is pumped down one hole where it picks up heat at depth as it passes through the fracture system. The hot water returns to the surface through a second hole and is piped through a heat exchanger where the heat is extracted and used to generate electrical power. Hatton reported that if the problem of impeded circulation of water through the fracture zone could be solved, LASL intended to connect a heat exchanger containing two 10-megawatt modules to the system. If the project proves successful at this stage, LASL plans to deepen the two drill holes to 12,500 feet and to connect a 100-megawatt heat exchanger to the system.

Baca Location No. 1, a huge block of privately owned land covering more than 100,000 acres, encompasses most of the Valles Caldera. Union Oil Company is attempting to develop a 50-megawatt power plant in the southwestern part of Baca Location No. 1. The BLM in its Rio

Grande Unit Resource Analyses compiled in 1979, estimated that the Baca Location No. 1 had the potential for the development of a 450-megawatt plant. Amax Exploration, Inc., also has been working on geothermal leases in the northeastern part of Baca Location No. 1 near the Santa Clara Reservation (U.S. Forest Service, personal communication, November 7, 1979).

The USGS (Godwin and others, 1971) officially designated more than 100,000 acres in the Valles Caldera region of the Jemez Mountains as a major Known Geothermal Resource Area (KGRA) in 1970. Three of the reservations contain land classified by the USGS as valuable for geothermal energy (USGS Area Geologist, personal communication, November 5, 1979). A description of the land classified as valuable for geothermal energy by the USGS in the vicinity of the reservations follows:

T. 19 N., R. 6 E., N.M.P.M.
T. 20 N., Rs. 5 and 6 E.
T. 21 N., Rs. 6 and 7 E.
T. 22 N., R. 9 E.,
    secs. 5 to 8, inclusive;
    secs. 17 to 20, inclusive;
    secs. 29 to 32, inclusive.

According to the USGS, the land in T. 20 N., R. 5 E., is within the KGRA. The Santa Clara Reservation has the most land designated as valuable for geothermal energy. Only a few hundred acres at the western end of the Sacred Area of the San Ildefonso Reservation and a few acres in the northeastern corner of the San Juan Reservation are classified as valuable for geothermal energy.

Nambe Reservation

Based on the data now available, the Nambe Reservation does not appear to have any mineral deposits that could be developed commercially. Possible metallic mineral resources include manganese and uranium. Possible nonmetallic mineral resources are clay and sand and gravel. No record of past production of any minerals from tribal lands for commercial use was found.

Metallic Mineral Resources

Manganese

Pennsylvanian limestone and shale in the southeastern part of the reservation may contain manganese-bearing minerals similar to those found in the Santa Fe manganese district, which is about 8 miles south of the Nambe Reservation (Elston, 1967). Pyrolusite and psilomelane, the manganese ore minerals in the district, occur as nodules and in small irregular pockets along the bedding planes and in fault breccia in the Pennsylvanian shale and limestone, Elston reports. He indicates that the only production from the district was a small amount during World War I, and that the district has not been productive since. If manganese mineralization similar to that found in the district were present on the reservation, it probably would not be considered a commercial deposit.

Uranium

Collins and Freeland (1956, p. 12) described three areas of anomalous radioactivity on the

Nambe Reservation, which were discovered by the use of an airborne scintillation counter, as follows:

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10. Location:
       SE ¼ sec. 2, T. 19 N., R. 9 E.
    Radioactivity:
       Background--0.02 MR/hr.
       Range of readings at anomaly --
       0.05-0.15 MR/hr.
    The anomalous radioactivity is
    associated with white and
    light-green opal that impreg-
    nates a coarse arkosic sand-
    stone layer within the
    reddish-gray siltstones of the
    Santa Fe formation. This layer
    averages 3 feet in thickness
    and can be traced for several
    hundred yards along the slope.
    Some radioactive opal also
    fills fractures and one nearby
    fault zone in the Santa Fe has
    been opalized. No uranium min-
    erals were observed.

11. Location:
       SW ¼ sec. 22, T. 19 N., R. 9 E.
    Radioactivity:
       Background--0.02 MR/hr.
       Range of readings at anomaly --
       0.05-0.20 MR/hr.
    The anomalous radioactivity is
    associated with a reddish-gray
    claystone interbedded with gray
    siltstones of the Santa Fe for-
    mation. The claystone averages
    5 feet in thickness and can be
    traced for 50 yards along the
    slope. No uranium minerals were
    observed.

12. Location:
       NE ¼ sec. 28, T. 19 N., R. 9 E.
    Radioactivity:
       Background--0.02 MR/hr.
       Range of readings at anomaly --
       0.05-0.30 MR/hr.
    Anomalous radioactivity is
    found over the outcrops of a
    reddish claystone and siltstone
    bed included within the gray
    siltstones of the Santa Fe for-
    mation. Minor amounts of a
    greenish secondary uranium min-
    eral occur as coatings along
    fractures and shears associated
    with bleached bedding planes in
    the red claystone. Fragments of
    opalized bone found in the ad-
    jacent gray sandstones of the
    Santa Fe formation are also
    radioactive.
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Collins and Freeland believed that if an ore body existed on the reservation, it probably would be found in the third area (no. 12) described. No ore bodies have been discovered on the reservation in the more than 20 years since their report was written.

Nonmetallic Mineral Resources

Clay

As Talmage and Wootton pointed out in 1937, clays have been found and used in nearly every part of New Mexico. According to George S. Austin, Deputy Director of the New Mexico Bureau of Mines and Mineral Resources (personal communication, November 6, 1979), the river clays in this general area occur only in small pockets and are generally of poor quality; however, adobe is abundant. Apparently, the use of clays on the Nambe Reservation has been restricted to making pottery and adobe bricks primarily for the personal use of the resident population. Commercial development of any clay deposits does not seem probable.

Sand and Gravel

Based on a geologic map produced by Kelley (1978), sand and gravel deposits should be present throughout most of the reservation. The Tesuque

Formation that underlies most of the reservation is composed of fanglomerate, conglomeratic sandstone, and coarse feldspathic sandstone interbedded with fine- to medium-grained sandstones, mudstones, and tuffs. Kelley's map also shows some Quaternary terrace gravels and alluvial valley fill. No data were found on the quality or quantity of sand and gravel on the reservation. No commercial production from the reservation has been reported. High quality sand and gravel in massive quantities is available along the Rio Grande in this area; therefore, the commercial development of sand and gravel on the Nambe Reservation does not seem probable.

Pojoaque Reservation

Apparently, no mineral deposits are being mined commercially on the Pojoaque Reservation. The only metallic mineral resource having possible development potential is uranium. Clays are present on the reservation. A mica processing plant is situated in the Pueblo Plaza industrial park on the reservation, but mica processed in the plant is not mined on Indian lands. At least five gravel pits have been worked on the reservation, but no production records were available. Sand and gravel deposits appear to be the only nonmetallic mineral resource having possible development potential.

Metallic Mineral Resource

Six areas of anomalous radioactivity have been reported on the Pojoaque Reservation. Five of these areas were discovered by the U.S. Atomic Energy Commission (AEC) during its airborne and ground survey of the Espanola area in November 1954. The sixth occurrence of anomalous radioactivity was reported in 1977 in a well drilled in the SW ¼ NW ¼ sec. 9, T. 19 N., R. 9 E.

Collins and Freeland (1956, p. 9-12) described the five areas discovered on the Pojoaque Reservation by the AEC as follows:

1 Location:
  Center of sec. 32, T. 20 N., R. 9 E.
  Radioactivity:
  Background--0.02 MR/hr.
  Range of readings over limonite-stained sandstone -- 0.05-0.3 MR/hr
  The anomalous radioactivity is associated with limonite staining in gray sandstone. The limonite staining is concentrated in zones containing clay galls, carbon trash and impressions of wood fragments. North and east of the occurrence, radioactivity of 3 to 4 times background can be detected over a dark brown iron-stained sandstone caprock. No uranium minerals were observed.

2. Location:
  South center of sec. 33, T. 20 N., R. 9 E.
  Radioactivity:
  Background--0.02 MR/hr.
  High--20.0+ MR/hr.
  High radioactivity is restricted to a thin surface cover composed of silty sand with included fragments of gray siltstone that overlies a gray, silty sandstone of the Santa Fe formation. The anomalous radioactivity from the soil cover can be traced for only 5 feet along the slope. The bedrock beneath shows no appreciable radioactivity. No uranium minerals were observed at the anomaly, and prospecting upslope failed to yield any source of the radioactive wash.

3. Location:
   Center of sec. 33, T. 20 N., R. 9 E., about 100 yards north of anomaly No. 2.
   Radioactivity:
   Background--0.02 MR/hr.
   Average--0.2 MR/hr.
   The anomalous radioactivity comes from a thin (¼ inch) coating of dark-brown iron (?) stain that coats a sandstone caprock over an area of 50 by 25 feet. No uranium minerals were observed at the anomaly.

8. Location:
   SE ¼ sec. 17, T. 19 N., R. 9 E.
   Radioactivity:
   Background--0.02 MR/hr.
   Range of readings at anomaly --0.1-0.4 MR/hr.
   The anomalous radioactivity is found over a bed of reddish-gray claystone several feet thick interbedded with gray siltstone in the Santa Fe formation. Minor amounts of yellow-green uranium minerals coat fractures and bedding planes in the claystone. The high radioactivity can be traced for about 100 feet along the exposure on the eastern side of a roadcut on U.S. Route 64 [now U.S. Route 84] southeast of Pojoaque.

9. Location:
   SE ¼ sec. 17, T. 19 N., R. 9 E.
   Radioactivity:
   Background--0.02 MR/hr.
   Range of readings at anomaly --0.2-2.0 MR/hr.
   The anomalous radioactivity is associated with limonite-stained carbon-trash pockets in gray siltstone of the Santa Fe formation. The radioactive zones are small, being only several feet in greatest dimension. Minor amounts of yellow, secondary uranium minerals were observed with the woody remains.

Collins and Freeland (1956, p. 15) considered the fourth area (no. 8) described above as showing the most potential for containing an ore body. No ore bodies have been discovered as yet.

At the sixth radioactive occurrence, the driller apparently told Pojoaque Pueblo officials that the well had penetrated highly radioactive material at two levels. A USGS memorandum dated February 15, 1978, indicated that USGS personnel have examined the well log and that the log did indicate the presence of a radioactive element at two levels in the well. The memorandum suggested that rock cuttings from the two intervals should be analyzed to determine which type of radioactive element is present. No further information about this occurrence was found.

Nonmetallic Mineral Resources

Clay

Small pockets of poor quality river clays probably exist along the flood plains of the Pojoaque River and the Rio Tesuque, and adobe deposits exist in the Tesuque Formation. Hawks (1970, p. 31) mentions a bentonitic tuff about 2 miles south of Pojoaque that was sampled by Needham and Peterson (Figure 2). Hawks (1970, p. 5) shows the location of this same sample (NP-12) about 2 miles north of Pojoaque on Figure 2 in his report. According to Hawks (1970), the sample was nonslaking and, therefore, was not tested intensively. Commercial development of any clay deposits does not seem probable.

Mica

According to Siemers and Austin (1979a, p. 48 and 49), the only mica mine operating in the State is the Tojo mine in southern Taos County. About 13,000 tons per year of sericite, a fine-grained mica, is produced at the mine by Mineral Industrial Commodities of America, Inc. (M.I.C.A.) The sericite is processed for use in paints and building materials at a 50-ton-per-day M.I.C.A. plant on the Pojoaque Reservation.

Sand and Gravel

Five gravel pits appear on the Pojoaque Reservation on the Espanola 7.5 minute quadrangle (topographic) map. The pits are in the south half of sec. 8, T. 19 N., R. 9 E., about ½ to 1-½ miles east of Pojoaque. The pits appear to be in an area underlain by the Tesuque Formation or Quaternary terrace gravels (Kelley, 1978). Quaternary alluvium along the Pojoaque River and the Rio Tesuque might be a source of sand and gravel. No records were found showing any commercial production of sand and gravel on the reservation. The quantity or quality of sand and gravel available on the reservation is not known, but it may have development potential.

San Ildefonso Reservation

All the mineral resources on the San Ildefonso Reservation appear to be nonmetallic. Clays are used for adobe bricks and for pottery. Pumice deposits exist in the western part of the reservation. Sand and gravel deposits are being worked at two locations. A few hundred acres of reservation land has been designated as valuable for geothermal energy.

Geothermal Resource

The USGS designated as valuable for geothermal energy the land in T. 19 N., R. 6 E., (USGS Area Geologist, personal communication, November 5, 1979). A few hundred acres of land at the western end of the Sacred Area is in that township. Most of the companies working on geothermal energy development in this region are interested in land several miles west of the reservation (Jiracek, 1974; Arnold and others, 1977).

Nonmetallic Mineral Resources

Clay

Common clay is used in making pottery for local use and for sale to the public. The black-on-black pottery produced on the San Ildefonso Reservation is famous for its beauty. Maria and Popvi Da, her son, are the most noted practitioners of this art form. Some of their products have sold for several thousand dollars apiece. As Talmage and Wootton (1937) pointed out, the Indian pottery trade may not be the most important part of the clay industry in New Mexico, but it probably is the best known. Common clays also are used in making adobe bricks for local building.

Hawks (1970, p. 32) describes a gray bentonite sample collected by Needham and Peterson from north of New Mexico State Highway 4 at the east boundary of Bandelier National Monument. According to Hawks, a rotary-mud analysis that was run on this bentonite produced only 14 barrels of mud per ton of clay, and the mud was not considered adequate for use in drilling.

Pumice

Pumice occurs along the southern and eastern slopes of the Jemez Mountains in beds generally 8 to 20 feet thick, and in many places, the pumice is covered by little or no overburden (Weber, 1965, p. 342). Elston in 1961 (p. 164) described the pumice reserves as inexhaustible, and he considered the pumice reserves in the Bandelier Rhyolite Tuff as very large in 1967 (p. 59). The geological map of the Espanola basin by Kelley (1978) shows that most of the Sacred Area on the reservation is underlain by the Bandelier Rhyolite Tuff that contains pumice.

Even though pumice deposits exist in the western part of the reservation, no pumice is being mined on the reservation, and no records of any past production were found. According to Siemers and Austin (1979a), only three pumice mines are active in New Mexico, and their combined production was about 710 cubic yards per day in the early part of 1979. The largest of these mines, the Copar mine operated by the Copar Pumice Company, Inc., is in secs. 31 and 32, T. 20 N., R. 7 E., about 2 miles west of the San Ildefonso Reservation on Santa Fe National Forest land. Siemers and Austin (1979b) show production capacity on the Copar mine as 300 cubic yards per day. Pumice deposits in this area appear to contain several million cubic yards, and at the present rate of production, the Copar mine could operate for many more years. The inactive White Eagle pumice mine owned by the Santa Fe Pumice Co. (Sheffer, 1962) is also on Santa Fe National Forest land in sec. 4, T. 19 N., R. 7 E., just west of the reservation boundary. Even though pumice deposits exist on the reservation, the potential for developing them does not appear to be good, because a sufficient amount of pumice is being produced from other sources to satisfy all commercial needs. If the U.S. Forest Service were to curtail leasing of its lands for the production of pumice, then the development potential for pumice on Indian land might improve.

Sand and Gravel

Sand and gravel deposits are common throughout New Mexico, and except for a few local areas, no shortage of the resource occurs (Siemers and Austin, 1979a). The Quaternary alluvial sand and gravel present in the valley of the Rio Grande constitutes the major source of this important commodity.

Nine gravel pits are shown on the San Ildefonso Reservation on the Puye 7.5 minute quadrangle (topographic) map as photo revised in 1977. Six of these gravel pits are in the Rio Grande flood plain in secs. 7 and 18, T. 19 N., R. 8 E. Two gravel pits are in the alluvial sediments in Guaje Canyon about ½ mile northwest of New Mexico State Highway 4 in the SE ¼ sec. 11, T. 19 N., R.

7 E. One gravel pit is near Totavi on the northwest side of New Mexico State Highway 4 in the SE ¼ sec. 15, T. 19 N., R. 7 E. BIA records in Santa Fe show only two active sand and gravel operations on this reservation.

McReynolds Construction Company of Espanola operates two small pits, 3.03 acres and 5.18 acres, respectively, at Totavi in the SE ¼ sec. 15, T. 19 N., R. 7 E. The mining contract dates back to 1974. The most recent production figures available report the removal of 53,649 cubic yards in the period from June 1, 1978, to August 31, 1979. During this period, monthly production topped 15,000 cubic yards twice. No estimates of reserves were available, and no data about the quality of the sand and gravel were obtained.

E. A. Alexander Sand and Gravel, Inc., of Santa Fe, operates on about 78 acres in sec. 7, T. 19 N., R. 8 E. Production figures from the BIA for this operation dating back to August 1974, show an output of 53,409 cubic yards of sand and gravel in the period from September 1, 1978, to August 31, 1979. The single largest monthly production was 9,385 cubic yards in August 1977.

The potential for more development of sand and gravel deposits is moderately good. According to Bingler (1968, p. 140), the sand and gravel produced in this area is used primarily in concrete for building purposes and in highway construction. The quality of sand and gravel available from the Rio Grande flood plain should be excellent, and the quantity should be tremendous. However, no precise data on the quantity or quality of sand and gravel on the reservation were available. On the negative side, sand and gravel does not appear to be in short supply in this area and is available on non-Indian land as is shown in the BLM Unit Resource Analyses compiled in 1979.

San Juan Reservation

The San Juan Reservation does not contain any known mineral resources other than common clay and sand and gravel. High quality pottery is made from the local clay. A project for making adobe bricks on the reservation has been sponsored by the Federal Economic Development Agency. Apparently, the bricks are to be sold to local builders for use in housing, but the U.S. Department of Housing and Urban Development (HUD) has created some regulations concerning the use of adobe in buildings that may limit the size of the local market (Frazier, 1980). Quaternary alluvial sand and gravel appears to be abundant along the Rio Grande flood plain (Kelley, 1978), but no data concerning any commercial sand and gravel operations on tribal lands were found. In fact, the available information does not indicate the presence of any sand and gravel operations on the reservation.

Santa Clara Reservation

Pumice and sand and gravel appear to be the only mineral resources on the Santa Clara Reservation, but a few other mineral occurrences have been noted on or near it. Collins and Freeland (1956, p. 10) reported the occurrence of anomalous radioactivity in the SE ¼ sec. 24, T. 20 N., R. 8 E., just east of the reservation boundary, but no uranium minerals were found at the site. Pottery is manufactured from local clays. Hawks (1970, p.

32) reported the presence of a nonslaking bentonite south of Espanola and the presence of a pink bentonite east of the town (Figure 2). Both of the bentonites occur outside the eastern boundary of the reservation, and they do not appear to have much development potential. A few thousand tons of diatomite was mined by the J. H. Rhodes Pumice Company, Inc., from a pit in the NE ¼ sec. 22, T. 21 N., R. 7 E. (Bingler, 1968, p. 134). The diatomite deposit is a lens in the Santa Fe Group that is truncated by erosion on the north and west and by faults on the south. The diatomite grades into siltstone to the east (Bingler, 1968, p. 136). Because the diatomite occurs more than 2-½ miles north of the reservation, appears to be an occurrence unique to that area, and grades into diatomaceous pumicite laterally and vertically, there is only a remote possibility that any diatomite would be found on the reservation.

Geothermal Resource

Approximately 20,000 acres of the Santa Clara Reservation (Figure 2) have been designated as valuable for geothermal energy by the U.S. Geological Survey (USGS Area Geologist, personal communication, November 5, 1979). Amax Exploration, Inc., has been actively developing geothermal leases just west of the reservation.

Nonmetallic Mineral Resources

Pumice

The Bandelier Rhyolite Tuff, which contains pumice, underlies several thousand acres in the west-central part of the Santa Clara Reservation (Kelley, 1978). No estimates of the quantity of pumice available have been made. Pumice probably has been produced from the reservation, but no production records were found. Sheffer (1962) stated that records in the office of the New Mexico State Mine Inspector showed that General Pumice Corp. of Santa Fe had worked on Puye Indian land in Rio Arriba County. The only pumice mine is operated by General Pumice Corp. on mining claims located on Santa Fe National Forest land in the S ½ sec. 17, T. 20 N., R. 7 E. According to the BLM Unit Resource Analyses of this region compiled in 1979, the claims were located in 1940, and pumice has been mined intermittently since 1951. According to this same report, General Pumice Corp. estimates its reserves at more than 3 million cubic yards. Siemers and Austin (1979b, p. 9 and 19) state that the mining operation is capable of producing 700 cubic yards per day, but the on-site plant can process only 350 cubic yards per day. The Cullum complex appears to be the largest active pumice operation in the State. Siemers and Austin (1979a, p. 50) in a report published earlier in the year stated that the Copar mine with a capacity of 300 cubic yards per day was the largest at that time.

General Pumice Corp. also is interested in the pumice deposits adjacent to the northern boundary of the reservation. Records of BLM in Santa Fe show that an application for patent is pending on five claims on public land in secs. 33 and 34, T. 21 N., R. 7 E. According to the BLM Unit Resource Analyses, no production has resulted from these claims since 1949, but pumice reserves on these five claims are estimated at 2,500,000 cubic yards.

Because of the availability of pumice from alternate sources and the apparent anti-development attitude of the Santa Clara Indians, pumice deposits on the reservations probably will not be developed in the foreseeable future.

Sand and Gravel

Large quantities of Quaternary alluvial sand and gravel are present in the flood plain of the Rio Grande (Kelley, 1978), but no evidence was found of any sand and gravel operations on tribal lands. No estimates of the quantity or quality of sand and gravel available on the reservation were found. The BLM in its Unit Resource Analyses discusses sand and gravel deposits on public land in this area. One company has a mining material sales contract with BLM for the removal of sand and gravel from Arroyo Seco on public land in Sec. 13, T. 20 N., R. 8 E. The lack of any sand and gravel operations on the reservation probably reflects the attitude of the Santa Clara Indians.

Tesuque Reservation

The only mineral resources on the Tesuque Reservation appear to be common clay, mica, and sand and gravel. Sand and gravel is the only commodity now being produced commercially. Several metallic minerals exist in small amounts in pegmatites that occur in the vicinity of Tesuque Pueblo Aspen Ranch, and two occurrences of anomalous radioactivity have been reported on the reservation.

Metallic Mineral Occurrences

Pegmatites

According to File and Northrop (1965, p. 28), the Aspen Mountain mining district, as defined by the New Mexico State Inspector of Mines, is in T. 18 N.,R. 10 E., and the district contains gold, silver, copper, manganese, lead, and zinc-bearing materials. Personnel of the Bureau of Mines collected and assayed 32 samples from this area in 1977 as part of a mineral survey of the Pecos Wilderness. Assay results from these samples do show that extremely small amounts of gold, silver, and base metals are present in the pegmatites north of Aspen Ranch, but no ore bodies were found during the mineral survey. The data suggest that finding of any ore bodies on Aspen Ranch is unlikely.

Radioactive Anomalies

Two areas of anomalous radioactivity were discovered by the Atomic Energy Commission (AEC) during an airborne and ground survey of the Espanola area in November 1954. Collins and Freeland (1956, p. 12 and 13) described the two areas discovered on the Tesuque Reservation by the AEC as follows:

13. Location:
    NW ¼ sec. 36, T. 19 N., R. 9 E.
    Radioactivity:
    Background--0.02 MR/hr.
    Range of reading at anomaly -- 0.07-0.3 MR/hr.
    The anomalous radioactivity is associated with a coarse, conglomeratic, arkosic layer within the reddish-gray sandstones and siltstones of the Santa Fe formation. The coarse zone averages 5 feet in thickness and can be traced for about 100 yards along the slope. The high radioactivity is associated with white opal which impregnates the coarse layer. No uranium minerals were observed.

14. Location:
    W ½ sec. 12, T. 18 N., R. 9 E.
    Radioactivity:
    Background--0.02 MR/hr.
    Range of readings at anomaly -- 0.06-0.10 MR/hr.
    The weakly anomalous radioactivity is related to light-colored opal that impregnates a 10-foot layer of coarse, arkosic sandstone and conglomerate in the Santa Fe formation. Points of weak radioactivity appear discontinuously through the coarse caprock for about 100 yards along the rim. No uranium minerals were observed at the anomaly.

Collins and Freeland (1956, p. 15) doubt that any ore grade material would be found in either of these areas. No ore bodies have been found in more than 20 years since the radioactive anomalies were discovered (Chenoweth, 1979).

Nonmetallic Mineral Resources

Clay

Common clay is used in making pottery on the Tesuque Reservation. Adobe is abundant (George S. Austin, Deputy Director, New Mexico Bureau of Mines and Mineral Resources, personal communication, November 6, 1979) and an adobe brick manufacturing operation might be developed because of the close proximity of the reservation to a potentially good market in Santa Fe.

Mica

Mica apparently was the mineral that was to be produced from the pegmatites north of Tesuque Pueblo Aspen Ranch. Fifty-seven mining claims were staked in sec. 1, T. 18 N., R. 10 E., and sec. 6, T. 18 N., R. 11 E., from 1955 to 1957. The claims are located on a pine-covered mountain just north of Aspen Ranch. The mountain is crisscrossed by bulldozer trails and trenches. Redmon (1961) examined the mica in this area, estimated that it constituted about 1 percent of the pegmatite, and suggested that it could be used only as scrap. According to Redmon (1961), a 1000-ton-per-day mill was to have been constructed in 1958. No mill exists at the site now, and no production has been reported from the area.

Sand and Gravel

Loomis Construction Co., Inc., of Santa Fe, is producing gravel from a 3-acre pit in the SE ¼ sec. 14, T. 18 N., R. 9 E. The lease was approved on

May 1, 1979. About 9,800 cubic yards were produced from the pit during the first six months of operation. The maximum monthly production was 5,063 cubic yards in September 1979. The pit is located in the alluvium of the Rio Tesuque flood plain. No data were found on the quality or quantity of sand and gravel available in this area, or on any other part of the reservation.

MAP COVERAGE

Topographic maps covering all the reservations are available from the U.S. Geological Survey. Fifteen maps of the 7.5 minute quadrangle series cover the entire area. Partial coverage of the area is available in the 15-minute quadrangle series, and total coverage is available in the United States Series of topographic maps at a scale of 1:250,000. For more information about purchasing topographic maps, the Index to Topographic Maps of New Mexico should be obtained from the Branch of Distribution, U.S. Geological Survey, Box 25286 Federal Center, Denver, Colo. 80225.

A geologic map of New Mexico also is available from the Branch of Distribution, USGS. A geologic map of the Espanola basin by Kelley (1978) can be purchased from the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico 87801.

The National Cartographic Information Center can supply information on the availability of cartographic data, such as multi-use maps, aerial photography, and space imagery. The address is the National Cartographic Information Center, U.S. Geological Survey, 507 National Center, Reston, Va. 22092.

Another source of map coverage of the reservation is the Bureau of Land Management, which publishes master title plats covering each township as well as surface management maps. Both the maps and the plats can be ordered from the Bureau of Land Management, Records Section, P. O. Box 1449, Santa Fe, N. Mex. 87501. An historical index can be obtained to accompany the master title plats. The quadrangles, master title plats, and historical indexes should be ordered by township and range. The New Mexico State Highway Department issues county road maps. Requests should be addressed to the New Mexico State Highway Department, Duplicating Services, P. O. Box 1149, Santa Fe, New Mexico 87503.

RECOMMENDATION FOR FURTHER WORK

To promote the development of the mineral resources on the six reservations, the tribes might give consideration to the following courses of action:

1. Examine land records to determine the status of both surface and subsurface mineral rights on the land covered by small holding claims or private land claims on the reservation. These claims generally are along the stream bottoms and may contain extensive sand and gravel deposits.

2. Determine the quantity, quality (composition), and location of sand and gravel deposits.

3. Investigate the possibility of having a drilling program undertaken on the Nambe and Pojoaque reservations to ascertain if undiscovered uranium ore bodies exist, although the probability of finding uranium ore bodies is not high.

4. Monitor the activities on the geothermal leases west of the reservations.

5. Determine the precise locations of pumice deposits with future development potential.

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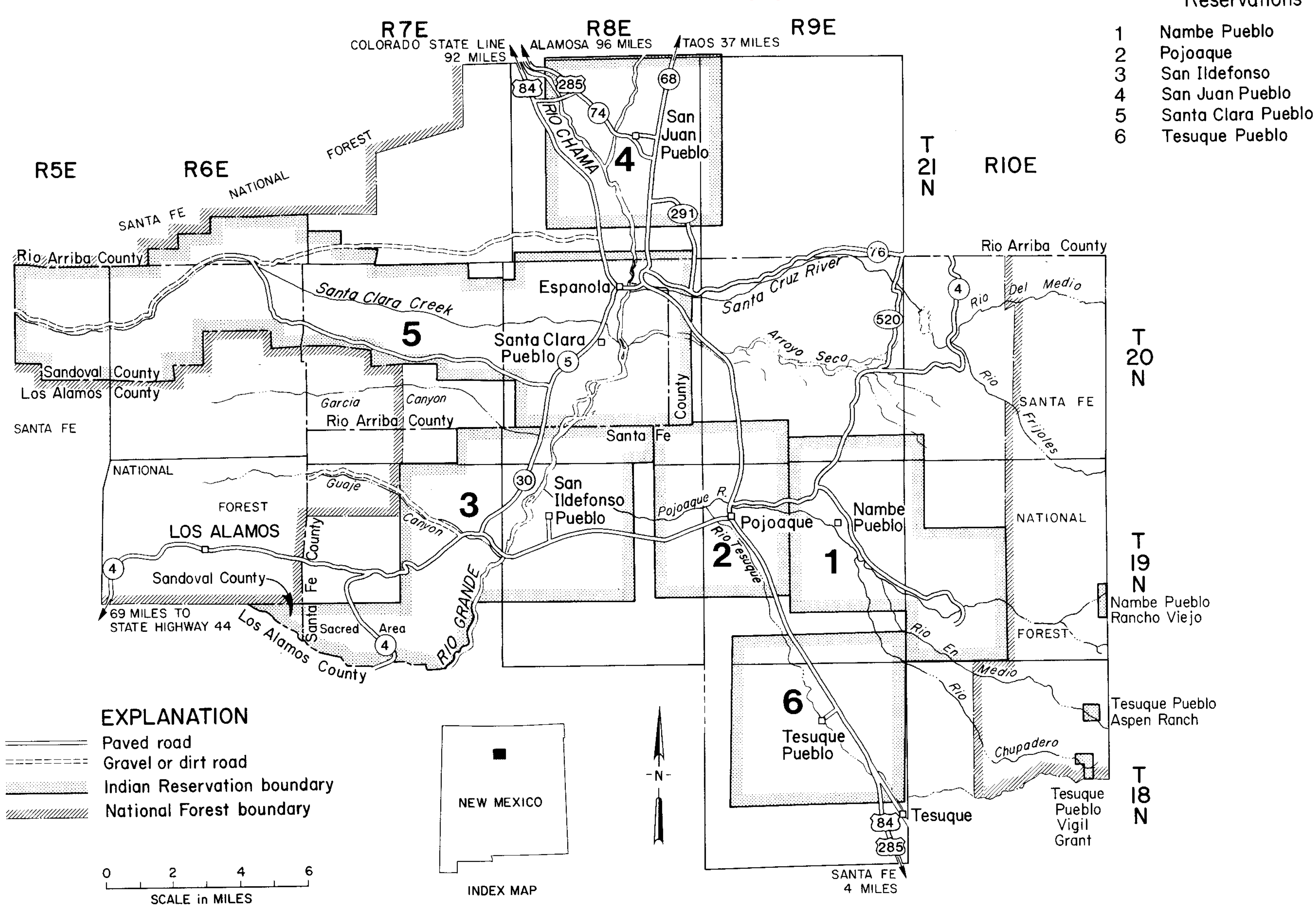

Figure 1. Map of Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Reservations in Rio Arriba, Sandoval, and Santa Fe Counties, New Mexico.

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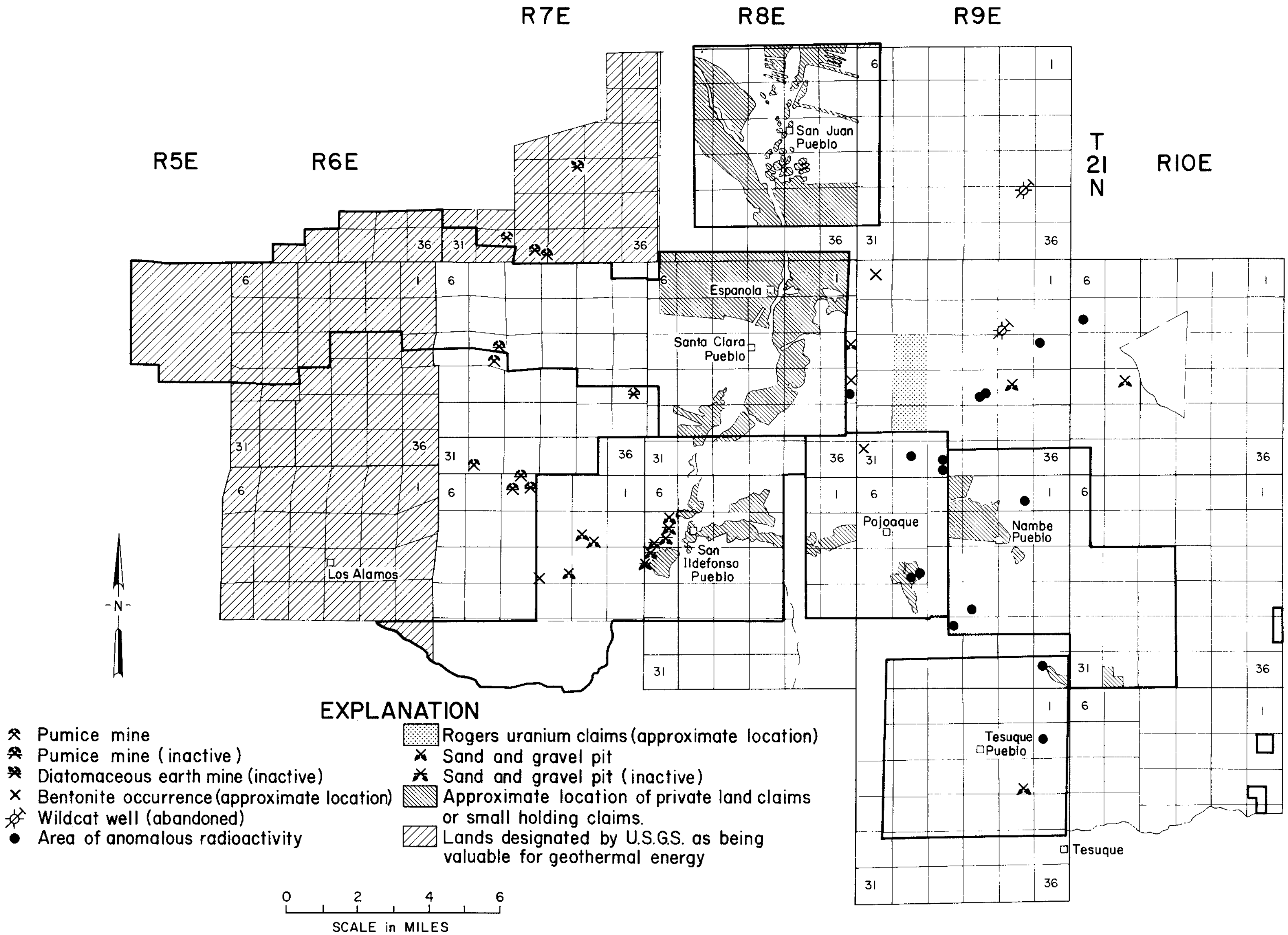

Figure 2. Land status and minerals occurrence map for Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Indian Reservation, New Mexico.

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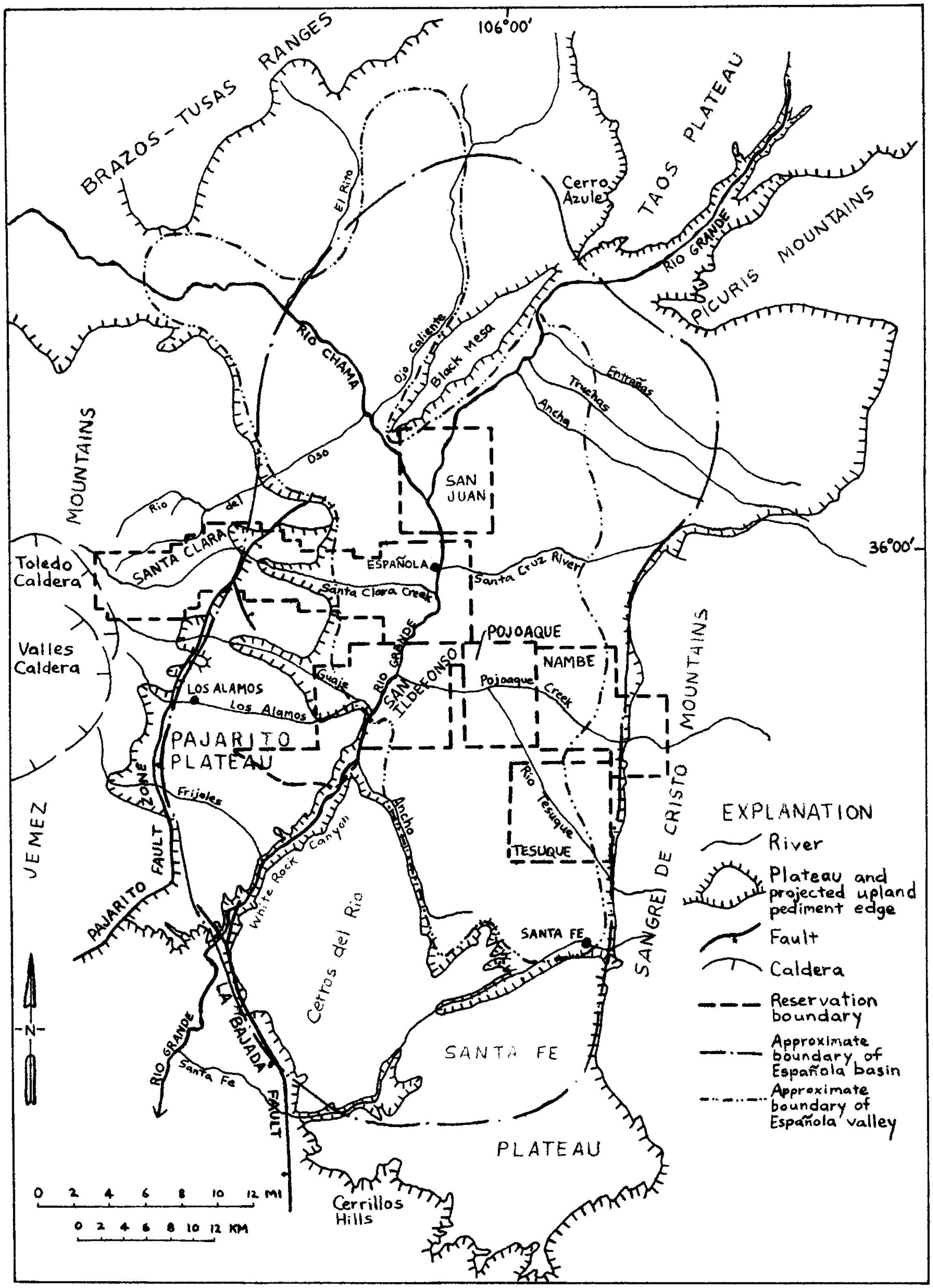

Figure 3. Physical setting of six northern New Mexico Indian Reservations described in this report (modified after Kelley, 1979).

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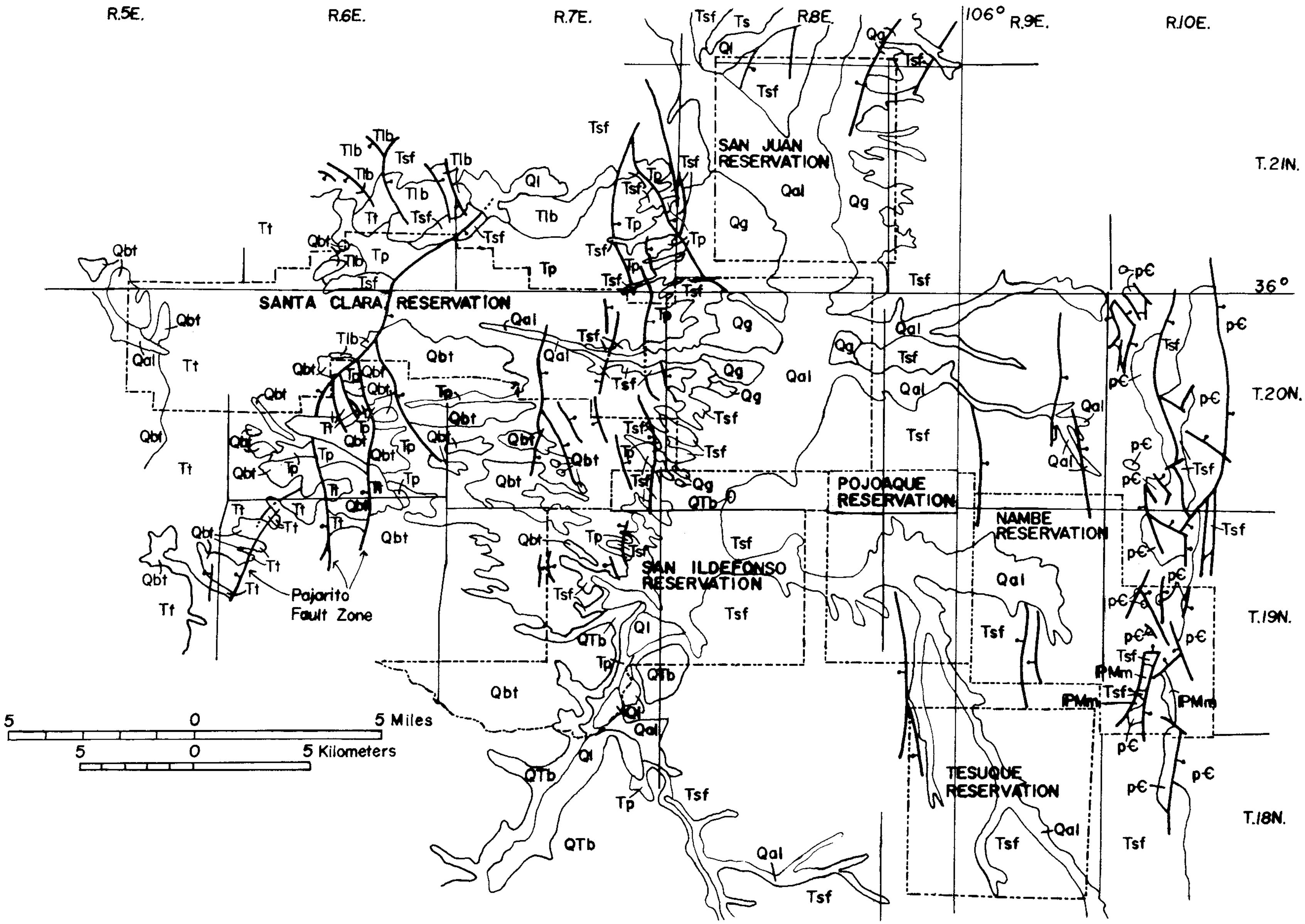

Figure 4. Geologic map of the Nambe, Pojoaque, San Ildefonso, San Juan, Santa Clara, and Tesuque Reservations, New Mexico. See Figure 5 for explanation. Compiled from several sources as noted in text.

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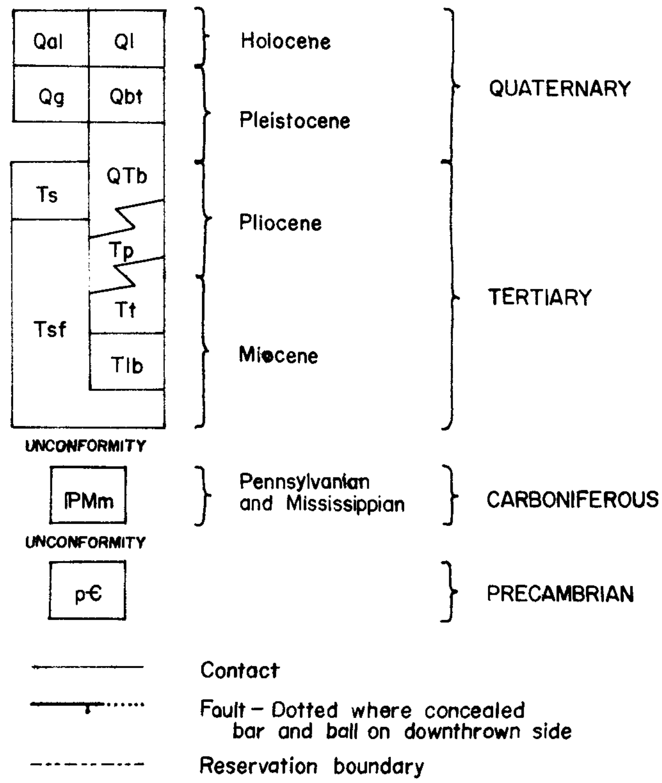

Qal	Alluvium
Ql	Landslide deposits
Qg	Terrace gravels
Qbt	Bandelier Tuff
QTb	Basaltic lavas and tuffs of the Cerros del Rio
Ts	Servilleta Basalt
Tp	Puyé Formation
Tt	Tschicoma Formation
Tlb	Lobato Basalt
Tsf	Santa Fe Group < Ancha Formation / Tesuque Formation
IPMm	Madera, Sandia, Tererro, and Espiritu Santo Formations
p€	Precambrian granite and metamorphic rocks

Figure 5. Explanation for geologic map, Figure 4.